My object in bringing together the facts related in the foregoing pages is to show that we may always proceed with some degree of certainty, if we never lose sight of positive, invariable landmarks. Beyond doubt the surest course is to trace the developments from the earliest growth of the ovule to the final perfection of the seed; but where this cannot be done, notwithstanding the variable texture and condition of the tunics developed from the growth of the primine and secundine, we may always, with much confidence, by attending to the unerring indications afforded by the raphe, generally deduce the true nature and origin of the different coatings of seeds in Phanerogamous plants.

III.—*On* Dracunculus *and Microscopic* Filaridæ *in the Island of Bombay.* By H. J. Carter, Esq., Bombay.

[With three Plates.]

In the month of October 1853, I published a "Note" on *Dracunculus* in the island of Bombay*, and in February 1858 communicated additional "Observations" on the same subject†, in order to correct and complete it. My object in the first communication was to give an anatomical description of the Guinea-worm of this island; to compare it and its young one with that microscopic species of the Filaridæ which is most common in the fresh-water tanks here, to which I have applied the name of "Tank-worm;" to try to account for the origin of *Dracunculus*; and to suggest some prophylactic measures for its prevention. This led me to a further study of the microscopic species, both in the fresh and brackish or salt waters of the island, which again threw my attention back upon *Dracunculus*, and has finally ended in making me acquainted, not only with much more of the anatomy of the latter, but with nearly the whole of the organology, formation of the ova and spermatozoa of the Tank-worm, as well as with several other microscopic species, all of which are interesting in various ways, but of which I have not been able to obtain much more than the external forms.

In my last communication, viz. the "Observations," I gave a short summary of the latter researches; and I now propose to give the full paper, with illustrations.

It may be conceived, perhaps, that much has been written on the Guinea-worm, and that publishing anything more about it is superfluous; but what has been written is very little to the purpose, and it is for this reason that it is desirable to record a

* Transactions Med. and Phys. Soc. Bombay, No. 2. p. 45, new series.
† Annals, vol. i. p. 410, 1858.

connected, exact, and complete description of it—which does not now exist. Besides, this could never have been acquired without a study of the microscopic Filaridæ which are to be found in the waters of the locality; while this study, again, has elicited facts which will be found acceptable both in physiology and natural history generally. Advantage also has been taken of the anatomy of the young Guinea-worm to confirm the existence of what otherwise might be doubted in the adult; and this, again, has afforded means of comparing the latter with the anatomy of the Tank-worm, for the purpose of pointing out the great resemblances between the two, and accounting for the modifications in form, &c., of *Dracunculus*, which appear to be induced by the circumstances under which it is developed.

The illustrations are numerous, and comprise, in the first plate, those of *Dracunculus*; the second plate is entirely devoted to a typical display of the organology, ovology, and spermatology of the microscopic species called the "Tank-worm;" and the third contains the forms of most of the other microscopic Filaridæ which have been observed. All the representations have been drawn after nature with great care, but with a leaning towards mathematical accuracy which renders them stiff and formal, though not the less effective for demonstrating the facts which they are intended to record.

I shall first describe the form and anatomy of *Dracunculus*, and then go to that of the Tank-worm; after which the other species of microscopic Filaridæ will be given, with some observations on them generally; and lastly, the whole considered with reference to the origin of *Dracunculus*.

The species of *Dracunculus* which occurs in the human subject in the island of Bombay, and probably in all India, is that which has been called "*Filaria Medinensis*," or "Guinea-worm;" and under this appellation it will be henceforth designated.

Filaria Medinensis, Gmel. Pl. I. fig. 1.

Female. Long, narrow, cylindrical, of equal size throughout, except towards the extremities, which are slightly attenuated. Smooth, white or colourless, unstriated transversely to the unaided eye, presenting two transparent and two opake lines running throughout the body, corresponding to the muscular bands and their intervals respectively. Anterior extremity or head (fig. 4) obtuse, round, furnished with two papillæ which are scarcely visible to the unaided eye, presenting, under a high microscopic power, a punctiform hole or mouth in the centre, surrounded by a smooth-bordered quadrangular space, on each side of which is a papilla, two of which papillæ are large and prominent, viz. those first mentioned, and situated above and

below the mouth respectively, while the other two are flat, rudimentary, and situated laterally. Besides this, there is another kind of armature extending from the rudimentary papillæ upwards and downwards, so as partly to encircle the head; but this is too faintly marked to require further notice; while the whole is fixed upon a kind of disk of concentric (muscular?) fibres, which is situated beneath the integument, and thus terminates this end of the body. From the four papillæ, which are situated at right angles to each other, as many whitish lines are seen to extend backward, of which those from the large papillæ pass into the centre of the muscular bands, where they are continued on faintly throughout the body, while those from the rudimentary papillæ pass into the transparent intervals between the bands. Thus, assuming that the opake bands, which are the great longitudinal muscles, are placed (as in *Ascaris lumbricoides*) above and below the alimentary canal, the large papillæ, being opposite them, will be vertically, and the rudimentary ones laterally situated, as before mentioned.

On the other hand, the posterior extremity (fig. 5) also appears obtuse to the unaided eye; but this, under a common magnifier, is observed to arise from an inflexion of the tail, which, being marked on its outer and inner curvature respectively by the great longitudinal muscles of the body, and the latter also by the termination of the rectum (*n*), as will presently be seen, may be assumed to be curved *ventrally*, where it is frequently fixed by an adventitious membrane (fig. 5 *o*). The anal orifice, as we shall also presently see, must be situated at the commencement of the tail, if the rectum has any opening at all externally, which I think very doubtful, as I have not yet been able to discover it; nor have I ever been able to see any trace of a vaginal opening or vulva.

The body consists of a firm cylindrical integument lined with a coating of muscular fibres, within which, again, loosely suspended by delicate filaments of cellular tissue in the peritoneal cavity, are the alimentary canal and generative organs.

Integument homogeneous, transparent though coriaceous.

Muscular coat consisting of some delicate circular fibres, which appear to be attached to the integument, and the two longitudinal muscular bands before mentioned, which are assumed, in accordance with what has been stated of *Ascaris lumbricoides*, to be respectively situated dorsally and ventrally. Peritoneal cavity empty, presenting towards each extremity a patch, about an inch long, of sarcoid (glandular?) prolongations, which are most marked anteriorly.

Alimentary canal (fig. 3) consisting of the œsophagus, intestine, and rectum, of which the two former are in a common

sheath divided by a constriction opposite their point of union. Œsophagus (*a*) straight, narrow, about 1-600th of an inch in diameter, commencing at the oral orifice and extending backwards for about two inches, where it becomes slightly dilated, and then joins the intestine; surrounded by the common or peritoneal sheath, within which again is the muscular one, both together forming a cylinder about 1-76th of an inch in diameter. Intestine (*b b*) much wider than the œsophagus, uniform in calibre, pursuing within its peritoneal sheath a tortuous course throughout the peritoneal cavity from being more or less twisted round the ovisac, and terminating almost close to the tail, in the rectum (*c*). Rectum only 1-8th of an inch long, without sheath, passing into the ventral muscular band or the inner curvature of the tail, beyond which I have not been able to trace it; that is to say, I have been unable to detect its connexion with an anal orifice in the integument over its termination, even under very favourable circumstances for examination, so that if there be any aperture of this kind at all, it must be extremely minute. Peritoneal sheath of the intestine the same or less in width than that of the œsophagus, which thus occasionally makes the intestine look less in diameter than the œsophagus, commencing from the constriction opposite the union of the œsophagus and intestine, and continued throughout of uniform diameter to the rectum. Hepatic organ consisting of a layer of brownish oil-globules which occupies the interval between the intestine and its sheath throughout, or probably terminating a little short of the end of the intestine, as shown in the young *Dracunculus* (fig. 6 *f*), where that which is not easily seen in this respect in the adult is supplied at once.

Organs of Generation (fig. 2). These consist of a large single ovisac (*b, b*), terminated by an ovary or small ovarian tube ateach extremity. The ovisac uniformly cylindrical throughout, about 1-24th of an inch in diameter, and occupying the greater part of the peritoneal cavity, extending to within an inch and a half of each extremity; membranous, without trace of constriction or projection in any part of its course, and terminating abruptly at each end in a narrow blind tube (the ovary), about an inch long, which is slightly dilated at its extremity. It is the abrupt termination of the ovisac a little short of the ends of the Guinea-worm which makes these parts of the latter more transparent than the rest of the body. The ovisac is filled with young Guinea-worms (all of which are of the same size) and some granular matter. An ovisac 26 inches long and 1-24th of an inch in diameter, which is about the average size in the adult Guinea-worm, should, if filled with young of the size to be hereafter mentioned, which is generally the case, contain upwards of half

a million. I have never seen any in capsules, or anything like the remains of capsules, though I think we may fairly infer that the granular matter is the remains of the embryonal envelopes, whatever these may have been.

There being no indication in the ovisac of any connexion with a vagina, and no vaginal orifice to be found externally, it might naturally be inferred that the ovisac could only obtain an exit by bursting through some part of the body, and that, as it is the head of *Dracunculus* which always protrudes first, this rupture is somewhere in its neighbourhood. To satisfy myself that such was the fact, I selected a case where the bleb which covers that part of the skin through which the head has ulcerated was unopened, and having carefully cut away the cuticle thus raised, saw the head of the Guinea-worm extruded for a line or two beyond the wound, when, on pouring some water over it, to see it more clearly, the ovisac immediately burst forth from it to the extent of an inch or more. I then carefully tied a piece of thread round the protruded part of the body of the Guinea-worm as far back as possible, and having prevented its retracting by drawing it out a little and placing another ligature beyond this, severed the worm between the two ligatures, and took away the head for microscopical examination. On proceeding with the latter, I found that the ovisac had passed out through a *distinctly* ruptured hole, which was situated 1-160th of an inch from the head; and knowing that no aperture exists here naturally, there could no longer be any doubt that the rupture had been occasioned by the distended ovisac, rendered much more so perhaps at the moment by the imbibition of the water which was poured over the wound just before the rupture took place.

Size. I have never yet measured a Guinea-worm which was beyond 32 inches in length, and, when fresh and fully distended, about 1-9th of an inch in breadth. This I should regard as the maximum size in Bombay; but they may be of all lengths below this.

Male. Not seen by myself. Professor Owen has figured one with an inflated, round, posterior extremity, and a single spiculum projecting from the apex, of which he states, "The caudal extremity of the male [*Filaria Medinensis*] is obtuse, and emits a single spiculum."

Young Dracunculus. Plate I. fig. 6.

Microscopic, filiform, minutely striated transversely, slightly diminishing towards the head, which is obtuse, tapering towards the tail, which is very long and whip-like; presenting a slight inflation at the root of the tail, to accommodate a glandular organ of the interior; head without papillæ; mouth punctiform,

in the centre of the anterior extremity; no vulva; anal orifice at the root of the tail. Alimentary canal commencing with a narrow, rigid œsophagus, ending in a much wider intestine, which is continued straight through the body, of uniform calibre, to the rectum, which is short, narrow, and proceeds obliquely to the anus. Œsophagus surrounded by a muscular sheath, and probably a peritoneal one; but the latter is not seen *in situ*, and the parts are too delicate to admit of its being demonstrated by their forcible expulsion, as in the adult, where it is also not visible *in situ*, but becomes evident when the œsophagus has followed the ovisac on its bursting through the body: thus the peritoneal sheath of the œsophagus would appear to be undistinguishable in both instances *in situ*, from being in contact with the muscular sheath, while in some of the microscopic Filaridæ it is separated by a distinct interval (Pl. III. figs. 29, 30). Peritoneal sheath of intestine continued from the constriction opposite the union of the œsophagus and intestine to the commencement of the rectum, where it terminates. Hepatic organ consisting of a layer of yellowish oil-globules, which occupies the interval between the intestine and its sheath from the œsophagus to within a short distance of the rectum, where it disappears and leaves the rest of the intestine only covered by the peritoneal sheath (fig. 6 *f*). Organs of generation undeveloped; no vulva. Size 1-33rd of an inch long and 1-633rd of an inch broad.

Obs. The transverse striæ are far more marked in the young than in the adult *Dracunculus*, where they are but just perceptible under a high microscopic power, and appear to be identical with the transverse muscular fibres, while in the young *Dracunculus* they are evidently corrugations of the integument.

Urolabes palustris, n. s. Pl. II. fig. 7.

Female. Linear, cylindrical, smooth, white or colourless, unstriated transversely, gradually diminishing towards the head, which is obtuse and terminated by a distinct labiate portion, furnished with at least two, if not four, indistinct papillæ; diminishing abruptly towards the tail, which is attenuated and whip-like. Mouth in the centre of the anterior extremity. Vulva a little in front of the middle of the body. Anus at the root of the tail.

Integument transparent, tough, apparently structureless, lined by a muscular coat, which only becomes visible under protrusion, when the former is ruptured. Muscular coat circumscribing the peritoneal cavity, presenting on its inner surface lines of oil-globules, and towards each extremity sarcoid glandi-

form prolongations, as in *Dracunculus*. The latter is a common feature in all the microscopic Filaridæ that I have examined.

Alimentary canal loosely suspended within the peritoneal cavity, consisting of an œsophagus, intestine, and rectum, of which the two former are ensheathed, and the latter naked. Œsophagus commencing with a cup-like or buccal cavity, into the posterior part of which projects a sharp-pointed, horny, narrow tube (fig. 11 *d*), which is continued backwards in a straight line to the intestine, and is exsertile at the oral orifice. Intestine much longer than the œsophagus, uniform in size, and passing straight through the body to terminate abruptly in the rectum, which is very narrow, short, and pursues an oblique course to the anus. Œsophageal sheath assumed to be double, consisting of a membranous (peritoneal) and a muscular portion, which are in contact with each other, and gradually increase in width from the mouth to the commencement of the intestine, where they are constricted, and the latter terminates, while the former is reflected on to form the peritoneal sheath of the intestine (*g*). The muscular portion has been wrongly called the œsophagus, while little or no notice has been taken of the horny tube which passes through its centre. The latter, which is also penetrating, is at once the organ of suction and that through which the nutriment is conveyed back to the intestine. I have seen drops of oil (the food) pass out of the point of this, under pressure, but never any trace of food in the sheath which surrounds it. Whether the horny tubular portion be again surrounded by a membranous tube, and thus form a kind of proboscidian organ, I have not been able to determine any further than the buccal dilatation goes, from which it is evidently separate; but it seems to me not improbable that this may be the case throughout, and that this tube may be moved backwards and forwards by a muscular apparatus in the bulbous part of the muscular sheath (see Pl. III. figs. 25, 26, and 27 *c*). But of this there is no doubt, that it or its immediate enclosing sheath is the only part which is in continuation with the intestine (fig. 11 *h*). Peritoneal sheath of intestine uniform in calibre throughout, or until it arrives within a short distance of the rectum, where it suddenly becomes smaller from the absence of the hepatic organ (fig. 7 *f*), and continues thus for some distance until it arrives at the rectum, where, like the intestine which it surrounds, it also abruptly terminates.

Hepatic organ consisting of a layer of yellowish-brown oleaginous globules, becoming amber-coloured posteriorly, occupying the interval between the intestine and its sheath, and extending from the commencement of the former to the part where the sheath becomes suddenly smaller, where they cease, or are only

sparsely scattered in groups (in cells?) over the remaining portion.

Posterior part of the intestine, which is sparsely covered with hepatic globules, presenting an irregular rhythmical influx and expulsion of water through the rectum, like that observed in some Naïdina, where it is produced by cilia for the influx, and by contraction of the intestine for expulsion.

Organs of Generation (fig. 8). Double, cylindrical, symmetrical, occupying the middle half of the body, each half consisting of an ovary and ovisac inflected upon the other part, which is the oviduct or fallopian tube. Ovary and ovisac continuous, formed of a delicate, membranous, pyramidal tube, blind at each extremity, and lying longitudinally in the peritoneal cavity, with the pointed or ovarian extremity towards the vulva, and the larger portion or ovisac in the opposite direction. Fallopian tube thick, muscular, arising from the ovisac at a little distance from the large extremity of the latter, which is thus rendered cæcal (figs. 8 *c* and 13 *d*), and presenting one or more constrictions and dilatations in its course towards the vulva, where it becomes suddenly narrowed and, uniting with its fellow of the opposite side, forms the vagina. Ovary and ovisac filled with ova in successive stages of development, up to the junction of the fallopian tube, beyond which they do not extend, the cæcal extremity being filled with a muco-granular matter only. Dilatations of the fallopian tube filled with spermatozoa (each of which is enclosed in its respective cell), and a greater or less number of ova, extending in single file up to the vagina.

Largest size 1-6th of an inch long and 1-370th of an inch broad.

Male (fig. 9). The same as the female, but smaller, and with the tail truncated almost close to the anus.

Organs of Generation (fig. 10). Double, occupying the middle half of the body, consisting of two cylindrical, delicate, membranous sacs of a pyramidal form, lying longitudinally in the peritoneal cavity, with their large ends approximated, each large end giving off a short narrow tube, which, becoming united, form a large seminal duct that is continued straight back to the neighbourhood of the rectum, where it terminates in a dilated portion, in the parietes of which are fixed two ensiform or scaphoid bodies of a horny consistence and yellowish colour, which together form the penis. These lie obliquely across the body, are thin, and curved longitudinally as well as transversely inwards, so that, when approximated at their pointed ends, they form a canaliculated, stiff, pointed, pyramidal, curved organ, which is exsertile at the anus.

Development of the Ovum (fig. 13). The ova first appear as a

mass of minute nucleated vesicles or cells occupying the pointed extremity of the ovisac, to which we have given the name of "ovary," and, gradually becoming larger with their distance from this point, at last come to occupy respectively an entire transverse portion of the tube, so as to form a single file of ova, which, divided by transverse straight lines, arising from the parallel approximation of their coats, thus cut the ovisac into graduated divisions, which increase in width as they approach the fallopian tube, where they end (*c*), the remaining cæcal portion being filled with the granular matter already mentioned, to which we shall direct our attention more particularly hereafter. Up to this point, the germinal vesicle and its nucleus, together with the yelk, are observed to be gradually increased in size, but not surrounded by more than one membrane, which is delicate, soft, and easily ruptured. The ovum now passes into the fallopian tube, which is filled with spermatophorous cells, each of which, as before stated, bears a single spermatozoon; and, as it traverses these, the germinal vesicle and its nucleus gradually disappear, and a second membrane, viz. the coriaceous coat, is added (*l*), when the ovum assumes an elliptical shape, and, arriving at the vagina, is laid before segmentation commences.

Development of the Spermatozoon (fig. 14). The spermatozoa are developed from minute nucleated cells which fill the small ends of the testicular sacs (*a*), which are in fact the testes, each of which cells consists of a cell-wall lined by a portion of protoplasm, in one part of which is the nucleus (fig. 15). The cell now increases in size, and a number of points or nuclei make their appearance in the endoplasm, thus giving it a granular appearance (16). These points or nuclei now enlarge, and each presents around itself a cell; during this process the whole mass has much increased in size, and the original nucleus may be assumed to perish (18). The endoplasm now gradually disappears, while the points or nuclei enclosed within their proper cells become larger and elongated, till at last nothing but a few fragments of the endoplasm remain, and the spermatophorous cells, which are indeed the daughter cells, are observed to be adherent to the inner periphery of the parent cell (19). At length the elongated nuclei with their cells force themselves through the parent cell, and, after remaining pendent to it for a short time, finally obtain their liberation, when the elongated nucleus of each cell is seen to be a spermatozoid (21). The spermatophorous cells thus liberated fill the large ends of the testicular sacs (14 *d*), and passing in this state into the seminal duct, are at length transferred from the male to the female, where, as before stated, they fill the dilated portions of the oviduct or fallopian tube (13 *g*, *k*). They are now observed to consist of a delicate, thin,

flexible cell, within which is the spermatozoon and a small fragment of granular matter, which, like that observed in the parent cell, appears to be the unemployed portion of the contents of the spermatophorous cell, which has not entered into the formation of the spermatozoon. The latter may now be seen to be writhing and twisting about in all directions, and giving a number of shapes to its cell as it forces it out in one direction and another (22), until it finally escapes, when it is observed to be linear, about 1-400th of an inch in length, consisting of a thick cephalic portion which is linear-fusiform and amounts to about two-thirds of the whole, and a thin, flexible, undulating portion which forms the other third, and is the tail (24). In this state it frequently appears among the contents of the testicular sacs, and always among those spermatophorous cells of the fallopian tube which are close to its junction with the ovisac.

According to this description of the development of the spermatozoa, it might be inferred that every spermatic or parent cell attains the same size, produces the same number of spermatophorous or daughter cells, and therefore each should contain a large number of spermatozoa; but such is not the case; for not only at an early period (that is, in the granular stage) are spermatic cells of different sizes to be seen, some of which are apparently filled with spermatophorous points (daughter cells in embryo), and others only containing two and three or upwards, indicating that the former will produce more than the latter (17), but at the end, when the whole of the endoplastic contents of the parent cell have become absorbed, with the exception of a fragment or two here and there, and the spermatozoa have nearly attained their full development, this is further confirmed by the presence of parent cells of different sizes containing from one to twenty spermatophorous cells (19). I therefore see no way of accounting for this variety in the size of the parent cell and in the contained number of spermatozoa, than by assuming that all the spermatic or parent cells do not develope the same number of spermatozoa, either from part of the granules or daughter cells becoming blighted, or from only a certain number being produced in the first instance. To endeavour to account for it by assuming that the *daughter cells* may develope one or more spermatozoa, and therefore that these may be the cells containing the few spermatozoa, would not be borne out by the contents of the few-bearing parent cells, which all present spermatophorous cells around their spermatozoa, while, if they had been daughter cells, the spermatozoa would have been all together, that is, not separated by a further cellular enclosure—an instance of which has never come under my observation.

The appearances presented by the contents *in situ* of the tes-

ticular sac, from its small towards its obtuse end, too, correspond with what they present when examined separately, after forcible expulsion (14). Thus, the small end is observed to be filled with small, delicate, nucleated cells (*a*); further on, these are much enlarged; then the mass presents a granular appearance, which becomes more marked progressively as the granules become larger (*b*); after which the granules assume an elongated form, which is the first sign of their being spermatozoa; radiated masses of spermatozoa now present themselves (*c*), and lastly, the mass of spermatophorous cells after they have left the parent cells, occupies the large end of the sac (*d*).

How the radiated arrangement is produced, I am unable to explain; for, up to the time of the spermatophorous or daughter cells leaving the parent cells, they appear to be disposed irregularly round the inner surface of the latter—at least such is their position after forcible expulsion (19 *d*). It is not uncommon, however, to see small parent cells containing a few spermatophorous cells with the spermatozoa radiating from one point (20 *a*); nor is it uncommon to see groups of spermatophorous cells without the parent cell, so attached together that all the heads of the spermatozoa are directed to one point (20); but on the other hand, as before stated, in the large parent cells, which contain a great many spermatophorous ones, they appear to be arranged irregularly round the periphery (18). If the large masses in the testicular sac (14 *c*) could be expelled entire, we might perhaps be able to see how this radiated arrangement is produced; but I must leave future investigation to point out this, and to explain why, in the larger cells, after forcible expulsion, they have not this arrangement, or whether they ever have it. Perhaps it is the forcible expulsion, after all, which destroys the radiated arrangement.

Again, as regards the spermatozoon: from possessing the form mentioned, which appears to be the normal one (24), many have the head of an intervening shape between bacilliform or linear and globular, but still always retaining the point or beak; while in the fallopian tube, sometimes, when the development of the ova appears to have ceased, and they have not been required, they are observed to have passed into still longer, bacillar, sharp-pointed bodies which have lost all vitality and become rigid and brittle.

Thus the development of the spermatozoa in their early stages corresponds exactly with what I have described and figured respecting their development in *Nais fusca**, that is, so far as the production of the granules or daughter cells in a nucleated parent cell is concerned, and these daughter cells becoming the sperma-

* Annals, series 3, vol. ii. p. 90, 1858.

tophorous ones; but here, in *Urolabes palustris*, while the development still goes on within the parent cell, and the spermatophorous cells adhere to its internal periphery, in *Nais fusca* the parent cell is lost, and the spermatophorous vesicles become fixed to a central albuminous mass until the spermatozoa are developed*.

The fact of the granules (which become the vesicles or daughter cells) being within the spermatic cells here, as well as in *Nais fusca*†, makes me doubt the interpretation which Dr. Nelson has given to their appearance in the testicle-sac of *Ascaris mystax*, where he states that the spermatic cells are met in their progress downwards through the testicular sac by a number of granules "which group themselves around" them, and continue about them until they get into the "uterus" of the female, where they drop off and form a "granular fluid," leaving the spermatic cells naked‡. As, however, my observations are based upon Dr. Nelson's statements, and not on actual examination of *A. mystax*, I will merely add, that the grouping of granules around the spermatic cell appears to me to be a phænomenon as inexplicable as it is anomalous.

That the spermatic cells themselves should be thrown off the inner surface of the testicular tube of *A. mystax* in "granules," I can easily conceive; but the impossibility of getting at the inner part of the end of the testicular tube in *Urolabes palustris*, left to the mere chance of the position it may take after bursting through the integument from pressure, and by moving the covering-slip of glass (for these parts are far too minute to be otherwise manipulated), is such, and the rapid imbibition of water by the cells situated there so distends the contents at the end of the tube, that it is impossible to ascertain anything satisfactorily beyond the fact that it does contain cells, and that these cells produce the spermatozoa. By a "granule" which passes into a nucleated cell here, I do not understand a simple aggregation of matter, but a point of complicated structure which we call a granule because its structure is too minute for us to demonstrate by the microscope.

Impregnation.—This appears to take place at the moment when the ovum reaches the mouth of the fallopian tube (13 *f*), and to require that the spermatozoon shall have left its cell before the incorporation can be accomplished,—1st, because the germinal vesicle and its nucleus appear full and prominent in the ovisac at this point, and disappear rapidly after the ovum has passed into the fallopian tube; 2ndly, because up to this time the ovum is without the coriaceous coat with which it afterwards

* Annals, vol. ii. pl. 3.
† *Id.* pl. 2. fig. 5.
‡ Phil. Trans. p. 505, &c., 1852.

becomes rapidly invested, and therefore at this moment ready with its soft thin coat to admit the spermatozoa; and, 3rdly, because the spermatozoon does not become active within its cell until it arrives at this point, where it may be found in all stages of liberation, in addition to being actually liberated. Moreover, it might be inferred that the cell would form an impediment to the ingress of the spermatozoon, an obstacle to incorporation, and a deciduous product which the ovum could ill accommodate. Thus, as the cells of the spermatozoa are thrown off at this point, it is not improbable also that their remains form the muco-granular contents of the cæcal end of the ovisac, to which I have already alluded.

Hab. Fresh water, in tanks and dirty drains wherever there is vegetable matter, mud, and putrescency, and in the gelatinous Algæ during the "rains." Breeding from January, and perhaps earlier, up to the end of April, but apparently not after. Abundant throughout the year.

Loc. Island of Bombay.

Urolabes Glœocapsarum, n. sp. Pl. III. fig. 25.

Female. Linear, cylindrical, striated transversely, gradually diminishing towards the head, which is obtuse and without papillæ; also towards the tail, which is long and furnished with a digital termination. Mouth in the centre of the anterior extremity. Vulva a little anterior to the middle of the body. Anus at the root of the tail.

Œsophagus commencing with a cup-like buccal cavity, from which a narrow straight tube is extended back to the intestine. Intestine much larger than the œsophagus, straight, and of equal calibre throughout, abruptly terminating in the rectum, which is narrow and obliquely directed towards the anus. Muscular sheath of the œsophagus commencing a little distance from the buccal dilatation, so as to leave a portion of the œsophagus naked, and, increasing in size backwards, presenting at first an oval and then a bulbous dilatation, after which it becomes constricted opposite the union of the œsophagus with the intestine. Intestinal sheath commencing with the intestine, and ending at the rectum. Hepatic organ consisting of a layer of brownish oil-globules occupying the interval between the intestine and its sheath throughout.

Organs of generation double, occupying the middle third of the body, as in the foregoing species; their form undetermined.

Size. 1-54th of an inch long and 1-376th of an inch broad.

Male. Somewhat smaller than the female; tail somewhat shorter and thicker; testis in the centre of the body, its form

undetermined; seminal duct and penis as in the foregoing species; penis exsertile at the anus.

Hab. The *Glœocapsa* which grows on walls and on the sides of gutters during the "rains."

Loc. Island of Bombay.

Urolabes labiata, n. sp. Pl. III. fig. 26.

Female. Linear, cylindrical, unstriated, gradually diminishing towards the head, which is labiated and furnished with two papillæ; also towards the tail, which is conical and elongated. Mouth in the centre of the anterior extremity. Vulva much behind the centre of the body, about the point of union of the posterior two quarters. Anus at the root of the tail.

Alimentary canal and œsophageal and intestinal sheaths, with hepatic organ, the same as in the foregoing species, but no buccal dilatation. Organs of generation apparently the same, but probably unsymmetrical, there being no room for the posterior half, on account of the backward situation of the vulva; their form undetermined.

Size. About 1-40th of an inch long and 1-774th broad.

Male. Unseen.

Hab. The *Glœocapsa* of the walls, &c., during the "rains."

Loc. Island of Bombay.

Urolabes tentaculata, n. sp. Pl. III. fig. 27.

Female. Linear, cylindrical, unstriated, gradually diminishing towards the head, which is obtuse and furnished with two short, thick, conical, tentacular prolongations, closely approximated at their base and turned outwards; also diminishing gradually towards the tail, which is conical and elongated. Mouth and anus as in the foregoing species. Vulva just behind the middle of the body.

Alimentary canal and œsophageal and intestinal sheaths, with hepatic organ, much the same as in the foregoing species, but no buccal dilatation. Organs of generation double, occupying the central portion of the body, their form undetermined.

Size. About 1-23rd of an inch long and 1-26th [?] of an inch broad.

Male. Unseen.

Hab. The same as the foregoing species.

Loc. Island of Bombay.

Urolabes cirrata, n. sp. Pl. III. fig. 28.

Female. Linear, cylindrical, unstriated, gradually diminishing towards the head, which is obtuse and furnished with two linear short cirri widely separated; also diminishing gradually to-

wards the tail, which is somewhat curved and obtuse at the extremity. Mouth and anus as in the foregoing species. Vulva in the posterior half of the body, a little in front of the union of the posterior two fourths.

Alimentary canal the same as in the foregoing species, but without buccal dilatation; the œsophageal sheath commencing close to the oral orifice, and gradually increasing in diameter backwards to its bulbous termination. Organs of generation undetermined.

Size. 1-73rd of an inch long and 1-1080th of an inch broad.

Male. Unseen.

Hab. Same as foregoing.

Loc. Island of Bombay.

The next species are all from salt or brackish water in the marshes of the island of Bombay.

Urolabes erythrops, n. sp. Pl. III. fig. 29.

Female. Linear, cylindrical, minutely striated transversely, ocellated, gradually diminishing towards the head, which is obtuse and without papillæ; also towards the tail, which is long and conical. Mouth and anus as in the foregoing species. Vulva just about the middle of the body.

Alimentary canal much the same as in the foregoing species. Œsophagus commencing with a cup-like, followed by a globular dilatation, after which it becomes narrow, uniform in width, and pursues a straight course back to the intestine. Peritoneal and muscular sheaths of the œsophagus distinct from each other. Intestinal sheath presenting a constriction just after its commencement, which gives it a globular form, part of which only is lined with the hepatic organ. Hepatic organ the same as in the foregoing species. Organs of generation double, occupying the middle third of the body; form undetermined.

Ocelli consisting of two globular bodies situated a short distance from the head, and between (?) the peritoneal and muscular sheaths of the œsophagus, opake, of a rich carmine colour in their posterior three-fourths, and the anterior fourth or corneal portion bluish opalescent.

Size. 1-20th of an inch long and 1-470th of an inch broad.

Male. The same as the female, but with the posterior part of the body terminating more abruptly and the tail more attenuated. Testis, seminal duct, and penis the same as in the foregoing species; form of the testis undetermined.

Hab. Silty clots of *Oscillatoria* floating in the salt-water main drain of the town of Bombay.

Loc. Island of Bombay.

Urolabes infrequens. Pl. III. fig. 30.

Female. The same as in the foregoing species, but a little larger in every way.

Alimentary canal and organs of generation the same generally. Ova undergoing segmentation and the embryo developed in the ovisac, but not liberated there.

Ocelli the same in situation, but semi-opake and of a yellowish colour throughout.

Size. Undetermined.

Male. Same as the female, but with a short curved tail, presenting on each side of the inner curvature a membranous expansion supported on setaceous ribs, which extends from the tip of the tail to some little distance above the anus. Organs of generation the same as in the foregoing species; form of testis undetermined.

Hab. Same.

Loc. Island of Bombay.

Urolabes ocellata, n. sp. Pl. III. fig. 31.

Female. Linear, cylindrical, unstriated, ocellated, diminishing gradually towards the head, which is obtuse and provided with four short linear cirri; also diminishing gradually towards the tail, which is short, somewhat curved, and furnished with a pointed digital termination. Mouth, vulva, and anus situated as in the foregoing species.

Alimentary canal the same, but with the œsophageal sheath more bulbous posteriorly, and no globular dilatation of the intestinal sheath posterior to it. Hepatic organ the same.

Ocelli the same as in *U. erythrops,* but smaller, less rich in colour, and a little nearer the head.

Size. About 1-32nd of an inch long.

Male. The same as the female, with the exception of the difference in the generative organs, which are the same as those of the foregoing species; form of testis undetermined.

Hab. Same.

Loc. Island of Bombay.

Urolabes barbata, n. sp. Pl. III. fig. 32.

Female. Body the same as the last, but much longer. Head furnished with four linear, short cirri. Tail short, somewhat curved, furnished with a short, pointed, digital termination. Mouth and anus the same. Vulva situated much posteriorly to the middle of the body, about the junction of the middle with the anterior third of the posterior half.

Alimentary canal the same as in the foregoing species, but the intestinal sheath terminating less abruptly upon the commence-

ment of the rectum. Hepatic organ the same. Organs of generation double, occupying the middle part of the body; their form undetermined. *Ocelli* at some distance from the head, of the same colour as in *U. infrequens*.

Size. 1-7th of an inch long and 1-600th of an inch broad.

Male. The same as the female, but with a large, thick, curved tail, obtuse at the extremity, tuberculated in its inner curvature, and furnished on each side with a row of short setæ extending from above the anus towards the tip; also three or four setæ on the outer curvature. Testis and penis the same as in the foregoing species; form of the testis undetermined.

Hab. Same.

Loc. Island of Bombay.

Urolabes parasitica, n. sp.

Female. Linear, cylindrical, unstriated, gradually diminishing towards the head, which is obtuse and without papillæ, and also towards the tail, which is long and conical. Mouth and anus as in the foregoing species. Vulva a little in front of the middle of the body.

Alimentary canal and hepatic organ the same. Œsophagus commencing in an expanded oral orifice, immediately becoming narrowed into a straight uniform tube; naked at the commencement, but soon surrounded by a sheath, which goes on increasing in width to the point of union of the œsophagus and intestine, after which it continues of uniform calibre to the termination of the latter. Organs of generation double, occupying the middle third of the body, their form undetermined; filled with ova diminishing in size with their distance from the vulva, and all presenting the germinal vesicle.

Size. 1-43rd of an inch long.

Male. Unseen.

Hab. Peritoneal cavity of *Nais albida*, in more or less abundance during the "rains," when this *Nais* makes its appearance in the *Glœocapsa* mentioned.

Loc. Island of Bombay*.

[To be continued.]

IV.—*On the occurrence of a Fish* (Pteraspis) *in the Lower Ludlow Rock*. By J. W. Salter, F.G.S.

The discovery of a true Fish in beds of the Silurian system considerably older than the famous "bone-bed" of the Upper Ludlow rocks is a fact of much interest. It is desirable at once

* For a small figure of this worm, see 'Annals,' series 3, vol. ii. pl. 4. fig. 50.